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FORMATION OF STUDENTS' RESEARCH ABILITIES WHILE STUDYING THE DISCIPLINE "OPTICS"

The article describes the methods for developing the research skills of future physics teachers in the process of studying optics at a university. The purpose of this study is to improve the research abilities of students in lectures, practical and laboratory classes in optics. In the course of pedagogical research, we developed a model for the formation of readiness for research activities in the school of future physics teachers and formed the criterion and tools for determining readiness, which were applied during the teaching of optics. And also, a number of pedagogical conditions are defined, which, in our opinion, form the research competencies of students. Methods of problem-based learning, practice-oriented learning, methods of analysis and synthesis, methods of observation were applied.

The relevance of the research topic lies in the problem of preparing future teachers of physics for organizing research activities with schoolchildren. Therefore, we have developed and tested the educational and methodological complex "Optics", proposed methods, forms, criteria for evaluating the research skills of future physics teachers.

The presented methodology for the formation of research competence can be used for teaching other basic disciplines. The results of the research will be relevant for teachers of pedagogical universities who are looking for effective ways to train future specialists who are able to qualitatively prepare students for research activities.

Keywords: research skills, research ability, competence formation, future teacher, teaching optics.

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«Оптика» пәнін оқу барысында студенттердің зерттеу қабілеттерін қалыптастыру

Мақалада ЖОО-да оптика пәнін оқу барысында болашақ физика мұғалімдерінің зерттеушілік дағдыларын дамыту әдістері сипатталған. Бұл зерттеудің мақсаты – оптикадан дәріс, практикалық және зертханалық сабақтарда студенттердің зерттеушілік қабілеттерін арттыру. Педагогикалық зерттеу барысында болашақ физика мұғалімдерінің мектебінде ғылыми-зерттеу іс-әрекетіне дайындығын қалыптастыру моделін жасап, оптиканы оқытуда қолданылған дайындықты анықтау критерийі мен құралдарын қалыптастырдық. Сондай-ақ, біздің ойымызша, студенттердің зерттеушілік құзіреттілігін қалыптастыратын бірқатар педагогикалық шарттар анықталған. Проблемалық оқыту әдістері, тәжірибеге бағытталған оқыту, талдау және синтез әдістері, бақылау әдістері қолданылды.

Зерттеу тақырыбының өзектілігі болашақ физика мұғалімдерін мектеп оқушыларымен ғылыми-зерттеу жұмыстарын ұйымдастыруға дайындау мәселесінде жатыр. Сондықтан біз болашақ физика пәні мұғалімдерінің зерттеушілік қабілетін бағалаудың әдіс-тәсілдерін, формаларын, критерийлерін ұсынған «Оптика» оқу-әдістемелік кешенін жасап, сынақтан өткіздік.

Зерттеу құзыреттілігін қалыптастырудың ұсынылған әдістемесін басқа базалық пәндерді оқыту үшін пайдалануға болады. Зерттеу нәтижелері студенттерді ғылыми-зерттеу іс-әрекетіне сапалы дайындауға қабілетті болашақ мамандарды дайындаудың тиімді жолдарын іздестірген педагогикалық жоғары оқу орындарының оқытушылары үшін өзекті болмақ.

Түйін сөздер: зерттеушілік дағдылар, зерттеушілік қабілет, құзыреттілік қалыптастыру, болашақ мұғалім, оптиканы оқыту.

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Формирование исследовательских способностей студентов при изучении дисциплины «Оптика»

В статье описаны методы развития исследовательских умений будущих учителей физики в процессе изучения оптики в вузе. Целью данного исследования является совершенствование исследовательских способностей студентов на лекционных, практических и лабораторных занятиях по оптике. В ходе педагогического исследования нами разработана модель формирования готовности к исследовательской деятельности в школе будущих учителей физики и сформирован критерий и средства определения готовности, которые применялись при обучении оптике. А также определен ряд педагогических условий, формирующих, на наш взгляд, исследовательские компетенции студентов. Применялись методы проблемного обучения, практико-ориентированного обучения, методы анализа и синтеза, методы наблюдения.

Актуальность темы исследования заключается в проблеме подготовки будущих учителей физики к организации исследовательской деятельности со школьниками. Поэтому нами разработан и апробирован учебно-методический комплекс «Оптика», предложены методы, формы, критерии оценки исследовательских умений будущих учителей физики.

Представленная методика формирования исследовательской компетенции может быть использована для преподавания других базовых дисциплин. Результаты исследования будут актуальны для преподавателей педагогических вузов, которые ищут эффективные пути подготовки будущих специалистов, способных качественно подготовить студентов к научно-исследовательской деятельности.

Ключевые слова: исследовательская умения, исследовательская способность, формирование компетенции, будущий учитель, преподавание оптики.

Introduction

From our point of view, within the study of basic disciplines, the content requires to include the training of a future teacher for the arrangement of research activities. Within the educational program “Physics”, “Physics and Mathematics” developed by the working group and currently being implemented, the content of the disciplines “Basics of research activity and academic writing” “Physical Experiment” contains relevant topics or components of research necessary to train students for research activities. Our research therefore was conducted while studying the mandatory component “Optics”. This discipline can serve as a base for shaping research skills of future physics teachers, since the shaping of research skills of future physics teachers can be efficiently arranged as part of their educational activities in the field of both theoretical research and physical experiment interrelated closely.

The empirical and theoretical levels of scientific research should be built in the training system of a future physics teacher. They determine the readiness and ability of the future teacher to perform scientific and pedagogical or educational research. They develop the ability to assess the degree of reliability of the results obtained using experimental or theoretical research methods. Creative thinking, skills of independent cognitive activity, the ability to simulate physics situations using a computer are developed; as part of education, students master the skills to plan and perform experiments (real and virtual), as well as the skills related to the processing and presentation of research results.

V.A. Mazilov believes that increasing the effectiveness of educational and professional training and professional development of the future teacher is associated with the need for pre-profile preparation of school graduates for admission to pedagogical universities. In particular, it is necessary to carry out work with school graduates to understand the motives and goals of choosing a pedagogical university and the profession of a teacher; an early acquaintance with the basics of the content of pedagogical activity, means and methods of its implementation is required. At the same time, in the process of studying at the university, students - future teachers need systematic psychological support for mastering the educational program (Mazilov V. A., Slepko Ju. N., 2022) [1].

The research work of students seems to teach them to diagnose their own professional activities. This is shown in the writings of A. Maslow (1982, 2001) [2,3], Denisova, D. et al. (2021) [4]. Students foremost need to be taught self-knowledge, they then will be able to study the results of their professional activities independently, goal-oriented and efficiently. Research thinking will switch from self-exploration (the inner world) to the outer one. In this case, future teachers shape direct and feedback links in their own research work.

Some foreign scientists believe that research competencies are shaped with online learning combined with face-to-face learning, where learning outcomes are significantly improved (Hibbard, L. 2016, Berseneva, O. V. ,2017, Choriev, I., 2019, Kalugina, N.L., et al. 2015, Pillay, H., et al.2007, Osipova, I. A.,2001) [5-10].

The analysis of the work of Ryndina YU.V. allowed us to identify the following pedagogical means of shaping research competence of students: problem lectures, topical hands-on, joint understanding reading and discussion of scientific texts by students and teachers, reflexive hands-on, research cases (Ryndina, Ju. V., 2011) [11]. Since the success of the problem lecture is ensured by the joint efforts of the teacher and the student audience, we considered our main task not so much to transmit information but to introduce students to objective contradictions. In the classroom, we put students in such conditions in which the knowledge necessary for further research work was gained by them not by learning it ready prepared, but by their independent "discovery", "invention", "gaining". This made it possible to reverse the timing of mastering new ideas and concepts and expand the range of ways mastered by the student to acquire it independently.

The main pedagogical functions of a physical experiment in the educational and cognitive process are considered: educative (shaping students' scientific worldview, physics thinking); developing (developing and deepening of experimental skills and abilities, developing of creative abilities); informational (the experiment procedure is an information carrier); methodological (provides a liaison of the conceptual framework of students with an empirical benchmark of science and technology); control and diagnostic (control over the process of learning of the material); professional-methodical (professional direction of the hands-on); educational (education of understanding of the beauty of physical experiment, rigor and proportionality of theory and engineering solutions to research objectives) (Rustamova, S. K., 2009) [12].

The goal of the research was to test the learning kit (LK) in the discipline "Optics", designed to improve the research competence of students.

The learning kit "Optics" is designed for the practical implementation of all components of the model of formation of readiness of students of pedagogical universities for research activities and achievement of the goals of each component of readiness (motivational, content - cognitive, creative and reflexive) and includes: syllabus of the course "Optics"; textbook for students "Optics. The nature of quantum radiation" (TB); lecture notes and presentations; guidelines for laboratory classes; methodological guidelines for practical classes: control and measuring materials (tools for assessing the formation of readiness); tasks for independent work. In the process of creating the learning kit, we proceeded from the fact that it should reflect the main content of the course "Optics" and ensure the achievement of subject learning outcomes and contribute to the formation of research abilities.

The lectures develop the skills to work with literature, the ability to analyze information, draw conclusions; comprehend the material in a logical way, highlighting the main thing in it; correlate, compare facts; collate and generalize new facts and phenomena; compare with already known data. In the textbook, topics gradually expand and deepen from the first to the twenty-eighth topic of the course, starting from geometric optics, then comes interference of light, diffraction, interaction of electromagnetic waves with matter and ending with the study of the quantum nature of light. Each section provides for the expansion of the physics material studied in the previous section. In the classroom, based on the creative activity in parallel with work on a direct educational task, a favorable communicative environment was generated: the elaboration of cooperation rules that contributed to the search for a common solution: problems were discussed and analyzed in joint work. Presentations were made and followed by reflection after each lesson. Students shared their impressions, expressed their opinion regarding the arrangement of the next lesson. Students' interest, activity, curiosity were manifested.

Hands-on classes hone the skills to solve complex problems; tasks with minor research activity; tasks of a searching, creative nature; to understand the essence and choose the course of solution; to analyze literature, compare, systematize pedagogical facts and phenomena; to see, understand and explain the content, causes and consequences, the process of occurrence and development of a particular pedagogical phenomenon. This contributes to the development of the interaction of knowledge and thinking skills in the student, which shape research skills and abilities. One of the ways to shape research competencies is the use of creative (practical) and experimental tasks in teaching physics lessons.

Creative tasks have a number of functions (Razumovskii V. G., Majer V. V., 2016) [13]: develop students' creative thinking; motivate students to study the discipline; activate cognitive interest; allow them to gain experience in creative activity; develop skills to independently seek solutions to educational problems; summon up students to achieve higher academic performance; promotes awareness with the use of physics knowledge in engineering and manufacturing, while ensuring unity of theoretical and practical aspects of training. According to V.G. Razumovsky, creative tasks fall under two types (Rogozhnikova, O., Konstantinov, N., 2021). [14, p.10]: 1. Research – respond to the question “Why?”; 2. Engineering – respond to the question “How to do?”. In physics, creative tasks can come in the following forms: computational; experimental (qualitative); in the form of questions which serve as a basis for laboratory work; problems for the work of practical physics (Bojkova, A. E., 2010) [15].

The experimental task is one of the types of school physical experiment that most fully reflects the structure of the experimental research method and allows persistently shaping and developing students’ research skills in physics lessons (Bojkova, A. E., 2010) [16].

Laboratory work shows up the structural composition of the bachelor in physics’ research competencies and indicators of their formation: positive dynamics for research activities; strong interest in working with sources of scientific information; finding and solving research problems; conscious and sound implementation of the stages of research activities; smart analysis of research results; reasonable determination of the place and meaning of the result; competent and logical presentation and protection of the results obtained; a steady desire to link the future profession with research activities.

Independent works shape skills to convincingly argue conclusions; draw their deductions, collect and summarize materials; participate in discussions and draw conclusions; participate in a community mini-study; summarize material in the form of a report, a research paper.

Materials and methods

We shall begin the description of the learning kit developed by us with the textbook “Optics. The quantum nature of radiation”. It includes: a lecture course on the main and additional topics; research tasks to consolidate new material and to develop creative thinking; problematic issues focused on the ability to perform research necessary to solve the problem. The principle of building a lecture course is implemented in the sequential study of 28 topics of the optics course.

The process of assimilation of new knowledge and the development of research skills is stimulated by the tasks of the textbook. Tasks involve the development of students’ thinking skills from the levels of knowledge, understanding, application to the levels of analysis, synthesis, creative approach, out-of-box thinking. The quiz after each section contains tasks, which solution involves individual, pair or group work of students.

The lectures use problem-based learning methods. An analysis of the literature shows that the problematic lecture is perceived by students with interest, contributes to a deeper assimilation of the material and, ultimately, is an effective pedagogical teaching tool (Andreevym V.I.,1988) [17]. Therefore, the use of problem-based situations in the lecture can contribute to a creative approach to solving problems. Problematic points: they should be complex enough to cause difficulties for students, and at the same time feasible for finding the answer on their own. Let us consider lectures on geometric optics. For example, under what condition a flat mirror can give a real image. Students know that the image in a flat mirror is always imaginary, a contradiction emerge. The search for a solution begins. They should guess that if a cone of light is directed at the mirror, it then gives a real image.

Thus, the use of proactive teaching methods, such as the problematic presentation of learning material in the study of the section “Geometric Optics” contributes to the construction of students’ deep knowledge in combination with the development of interest and motivational aspects in the learning process and give boost to students’ research activities.

During hands-on classes, all participants in the educational process (students of different groups, teachers) exchange knowledge and ideas. During our teaching experience, we noticed that the processes of self-control for each of the group participants in hands-on classes are more favorable; the search for definitions, operations, and self-assessment of their actions proceeds more intensively in the group and allows them to master research skills.

Task compiling regards the classification of academic and creative tasks proposed by V.I. Andreyev and used by O.V. Fedina (1988,2008) [18,19]. Each task falls into three levels of difficulty. In the beginning, regardless of their abilities, students are offered tasks of the first level – the most difficult. The teacher only designates the problem, all the rest of the work: defining the task, preparing and staging the experiment, processing the results is performed by them independently. The teacher monitors the implementation of the task and only in extreme cases (non-compliance with safety regulations, the threat of device breakdown) intervenes in the process. Sometimes students find very original ways to solve tasks that are not provided by the teacher. If they do not cope with the task, they are invited to move on to solving problems of the second level of complexity. For the tasks of the second level, the problem remains the same, the wording just has been changed to have some hints: the range of devices and materials is limited, various ways of completing the task are outlined. The third level of tasks is offered to students if they are unable to complete the previous one. It is simplified as much as possible, but it still has the elements of creativity. If it is impossible to make a task in three levels of difficulty, students are offered help cards that help them find the right solution. A help card is a card with a prepared question, diagram, drawing, formula, etc. The card gradually narrows down the field of solution search without giving a direct answer (Bitibaeva Zh.M. 2020) [20].

Table 1. Structure of a problem lecture on optics as an example of topics in the section "Geometric optics".

Lecture stages	Lecturer's goal	Lecturer's techniques
Introduction	To capture the attention of the audience, arouse interest	Task: the mirror can reflect 90% of the light energy, but snow also reflects about 80% of the light energy. Why can't we see our reflection in the snow?
Problem setting	To show the relevance of the problem, to analyze contradictions, partial problems, to outline a general problem	There are collecting and scattering lenses. How can the power of lenses be compared without measuring focal lengths? Compare it. Problem: how to compare the optical forces of lenses without measuring the focal length. Students should have a deeper understanding of the concept of optical power. To understand that it characterizes the refractive ability of the lens and guess how to fold these two lenses so that their main optical axes coincide. They then will try to get an image from a distant source. If the image is obtained, then the optical power of the collecting lens is greater. If the optical power of the scattering lens is greater, then the image will not work.
Breaking up the problem into subproblems of the task, the question	To clearly separate out the list of problems, tasks, questions, reveal their essence	Geometric optics is based on three laws: law of rectilinear propagation of light; the law of light reflection; the refraction law. Giving examples of rectilinear propagation of light. Task 1: Why are there several shadows? As a result of the conversation, it is established that when approaching the source ceases to be a point, and each section of the filament becomes independent, therefore several shadows emerge. Task 2: How can I get a shadow and partial shade from an object? Students conduct experiments with a ball using two light sources.
Statement of own position, approaches, solutions	To show his/her own approaches, positions and other views in a comparative analysis	It makes sense to demonstrate the experience showing that a biconvex lens is not always collecting, and a biconcave lens is scattering. Students substantiate proofs, judgments, arguments, use techniques of critical analysis, comparison
Summary, conclusions	To concentrate the audience's attention on the main thing, to summarize what was said	Since light is electromagnetic radiation and it has all the properties of electromagnetic waves, all the problems of optics can be solved based on wave representations. When solving problems of constructing images in mirrors and lenses and when calculating optical devices, scientists use geometric methods. These methods make up the content of geometric optics, which is otherwise called beam optics. The basic concepts of geometric optics are beam and ray.

In laboratory classes, the goal was to shape students' research skills about the modern representation of the physics phenomenon of the world and the skills of using the basic laws of physics in research activities; to acquire skills in solving physics problems emerging in the field related to professional activity. As well as to shape research skills, obtain and process experimental results; the ability to model physics processes in solving specific tasks related to professional activity (Bojkova, A. E. 2010) [15].

We present the laboratory work developed during the study. These developments include all the necessary components for their successful implementation: the goal of the work, a summary of the theoretical content, virtual models of laboratory work, the algorithm of work, control and measuring materials.

To shape students' research skills, two tasks were defined:

1) to identify laboratory work on optics;

2) to select application software that provides automatic processing of calculation results, as well as the plotting and analysis of graphs.

To perform the first task, a complex of laboratory work on optics was selected, on the installations of which it is possible to study and investigate physical law. The hands-on includes 10 laboratory works. Each work contains a mandatory part to perform and a part containing research components. MS Excel spreadsheets, which are the equivalent of simple tables, with various data (text, numbers, date, formulas) recorded in their cells, were chosen as a tool for processing laboratory hands-on data.

The key advantage of spreadsheets is the ability to instantly recalculate the results in all formulas when the source data changes. In addition, they enable to perform the single-type calculations of large data sets, build and edit graphs and diagrams, find the sought values from the graphs and evaluate their errors.

While performing the proposed tasks, students master the methods of education activity, as well as the methods of cognitive activity that contribute to the formation of research skills. Students master the skills of operating the main instruments and equipment of a modern physics laboratory, processing and interpreting the results of an experiment, including using computer technology and information technology.

Performing laboratory work of this type generates interest in scientific activity, expands professional and pedagogical knowledge, and shapes research skills.

Thus, the solution of search tasks and the performance of laboratory work is the logical conclusion of a series of educational empirical studies, within the formation of research skills. Such activity of the future teacher stimulates a high-quality level of educational research, its entirety and completeness, will form some components of the teacher's methodological readiness to compile a description for laboratory work and its approbation, along with research skills.

Results and Discussion

In the course of the study, we developed models of indicators, control and measuring materials, diagnostics, and an increase in the level of future prospects.

The study was conducted at Pavlodar Pedagogical University, with third-year students majoring in the educational programs

"Mathematics and Physics",

"Physics and Computer Science",

during the study of the discipline "Optics". 36 students were involved in the study.

As part of observing students in the classroom and analyzing their written creative works, we defined the levels: high, sufficient, threshold, low, critical. Our experimental learning did not use reference groups.

We diagnosed the qualities of the research skills to be shaped before and after the application of our developed learning kit. The primary study (questionnaire of students) was conducted after the students performed traditional laboratory work on optics.

Later according to the plan of our experiment, the students started learning according to the learning kit developed by us.

The criteria which enable to determine the levels of research skills shaped are given in Table 2 (Fedina, O. V., 2008) [18, p. 42-44]. The learning experiment was conducted in a way that each student performed the tasks consistently proposed by us. The research was conducted as part of the study of optics topics. Some of the tasks were performed at the expense of the student's independent work and office hours.

The final diagnosis of the level of research skills shaped was performed according to the criteria (see Table 2), by checking written papers and face-to-face interviews with students. In the study by O.V. Fedina, three levels of formation of research skills are identified: "low", "medium" and "high". We have added two more criteria, this allowed us to fairly fully and objectively assess the level of formation of research skills.

Table 2. Criteria for the level of formation of research skills

Criteria	Level and score of formation of research skills				
	Critical /1	Low/2	Threshold /3	Sufficient /4	High/5
A. Attitude toward research activities	Classes skipped, no interest shown	Classes are boring, lack of interest	Classes out of necessity, with no interest	Showing erratic interest	Display of proactive interest going into a hobby
B. Attitude toward sources of scientific information	Having no clue	Does not know how to work with reading material	Lack of independent interest in sources containing scientific information	Display of erratic interest in sources of scientific information;	Display of sustainable interest in the sources of scientific
C. Nature of practical actions	Nill	Show only when working with a group	Executive only	Partially exploratory	Self-execution of the research
D. Rationality and sequence of operations	Nill	Random actions	The sequence is chaotic irrational	The sequence is not sufficiently thought thru	Performing all operations consistently, thoughtfully, rationally
E. Degree of self-sufficiency in performing operations	Complete lack of autonomy	Can only work in a group	Inability to work solo	Holding solo research work partially	High degree of independence at all stages of research activity
F. Persistence at performing an operation	Nill	Appears only when paired	Finding a solution can easily be interrupted	Finding a single solution, inability to find an alternative solution	Dissatisfaction with the result obtained, search for new solutions
G. Analysis of the operation performed and the result obtained	Nill	Irregular analysis	Lack of analysis of the solution and the result obtained	A shallow analysis of the solution and the result obtained	Robust analysis of the solution and the result obtained
H. Manual dexterity	Nill	Low display	Poorly developed	Developed	Well-developed
I. Confidence in the operation performed	Nill	Complete lack of confidence	Uncertainty about the results obtained	Inability to defend and present the results properly	Competent and logical presentation and defense of the results obtained
J. Attitude toward the operation performed	Nill	Pessimistic	misunderstanding of the meaning of the result obtained	Inability to independently determine the place and meaning of the result obtained	Independent determination of the place and value of the result obtained
K. Skills generality	Nill	Application in a similar situation	Application based on example only	Application in a slightly modified situation	Wide application to any field of activity
L. Awareness of the action as a whole	Nill	Poor awareness	Performs an action unconsciously, through trial and error	Performs an action half consciously, not anticipating the end result	Performs the action consciously, anticipating the end result
M. Attitude toward a problem	Nill	Indifferent	Display off and on	Solving the problems posed	Finding problems
N. The completeness and depth of the operations performed, which the action as a whole is composed of	Nill	Narrow, shallow	Sometimes successful	Medium	Complete, deep
O. Professional intentions	Nill	Poor display	Associates future professional activity with the fulfillment of the designated job scope	The desire to partially link the future occupation with research activities	A strong desire to link his/her occupation with research activities

The obtained values of the readiness component indicators for each student were translated into readiness scores with a maximum score of 5 and a minimum score of 1.

$$X = \frac{A + B + C + D + E + F + G + H + I + J + K + L + M + N + O}{15}$$

Analysis of the results at the beginning of the study, at the beginning of the semester, showed that the level of development of research skills and abilities has low indicators - threshold and low marks prevail. Students do not know how to select the necessary information on the basis of available scientific literature, do not show perseverance when performing an operation, and do not know how to analyze problem solutions. Things are not going well with the formulation of the main points of the research methodology. There are shortcomings in the conduct of empirical research; writing and style of presentation suffer.

At the final stage of the study, at the end of the semester, a re-diagnosis of the level of development of students' research skills and abilities was carried out using the same methodology.

As evidenced by the data obtained, the indicators of the average and high levels of development of research skills have increased markedly. Let's check if these positive changes are statistically significant. Since we are dealing with shifts of the studied trait, we use the Wilcoxon statistical T-test.

H_0: Post-experiment scores are higher than pre-experiment scores. H_1: Post-experiment scores are less than pre-experiment scores.

The sum of the rank column is equal to ∑=666. Checking the correctness of the matrix based on the calculation of the checksum:

$$\sum x_{ij} = \frac{(1+n)n}{2} = \frac{(1+36)36}{2} = 666$$

The column sum and the checksum are equal, so the ranking is correct. Now let us mark the directions that are atypical, in this case, negative. The sum of the ranks of these “rare” directions is the empirical value of the criterion T: $T=\sum R_t=26+26=52$

We use the table to find the critical values for the Wilcoxon rank sum test for n=36: $T_{cr}=185$ ($p\leq0.01$). $T_{cr}=227$ ($p\leq0.05$). The zone of significance in this case extends to the left; indeed, if there were no “rare”, in this case positive, directions at all, then the sum of their ranks would be zero. In this case, however, the empirical value of T falls into the zone of significance: T emp <Tcr(0,01). Hypothesis H_0 is accepted. Post-experiment indicators exceed the values of pre-experiment indicators.

There is a statistically significant positive shift: the indicators of the research skills development level at the end of term have increased vs the same indicators at the term beginning.

Experimental-pedagogical work on the development of research competence while studying the disciplines “Optics” had a positive result. Thus, the results obtained in a small sample population are reliable. These results can be extended to the entire general population of students, and methodological recommendations can be given.

Conclusions

Thus, the hypothesis put forward about the positive impact of the learning kit developed by us, as well as the models, criteria and evaluation methods for them on the process of shaping research skills was tested and confirmed by experiment. It is worth to note that the work performed had a positive impact on the motivation to study in general. Students self-consciously approached the performance of educational tasks, understood their significance and reasonability (Aleksandrovich, P.I., 2009). [21].

Shaping students’ research skills to conduct research activities was one of the main tasks of experimental work. Identification and comparison of the degree of formation of research skills was performed according to the specified indicators. As part of the research, we are required to confirm the correctness of the justification of the possibility of developing and establishing the research skills of future physics teachers at a pedagogical university when studying the discipline “Optics”.

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